CHEMISTRY AND MINERALOGY OF SAMPLES FROM THE BAYOU CHOCTAW, BRYAN MOUND, SULFUR MINES, WEEKS ISLAND AND WEST HACKBERRY STRATEGIC PETROLEUM RESERVE SITES
November 1979 through August 1982

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ABSTRACT

Chemical and mineralogical data collected on salt core, brine and related samples from five Strategic Petroleum Reserve (SPR) sites over the last three years are collected here for the purpose of documentation and easy reference. The data include identification of the minerals present in bulk core samples and in the water insoluble fractions of core, chemical analysis and densities of core and brine samples, and chemical analysis and mineral identification of materials produced during cavern leaching and during tests conducted on salt dome samples. Core samples are typically greater than 90% halite with the remainder anhydrite. Water insoluble minerals present during various stages of the leaching process are anhydrite and very small amounts of dolomite, calcite, barite and silicate minerals; and a water insoluble mineral inside Bryan Mound brine lines is vaterite. Brine samples analyzed are typically at or near NaCl saturation and contain variable amounts of Ca^{++} (0.15 to 2.8 mg/g) and $SO_4^{=}$ (0.41 to 4.1 mg/g).

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INTRODUCTION

During the last three years the analytical laboratories in Deparment 1820 have performed chemical and/or mineralogical analyses on over 130 Strategic Petroleum Reserve (SPR) samples from five SPR sites. Results of these analyses have been reported to the Sandia SPR Geotechnical Division (currently Division 9757) in a series of laboratory analysis sample cards and memos. A previous report (Reference 1) provided a detailed compilation, description and interpretation of analyses of Bryan Mound, Texas, salt dome samples completed as of May 1980. The purpose of the current report is to bring together in one document the results of analyses completed as of August 31, 1982 on samples from the Bayou Choctaw, Sulfur Mines, Weeks Island, and West Hackberry, Louisiana, salt domes. Analyses of Bryan Mound samples that were completed after the preparation of Reference 1 are also included. Data for each type of analysis for each salt dome are brought together in concise tables and reported in consistent units. Sample descriptions of the samples actually analyzed are also provided here where they can be easily tied to the analytical results. It is not the purpose of this report to attempt to provide a detailed discussion or interpretation of the data. Much of this was done for Bryan Mound in Reference 1 and applies equally well to the salt domes and data covered in the current report. Reference 1 also contains background information on the SPR, a glossary, details of analytical methods, information on sample nomenclature conventions, and lists of mineral names and chemical formulas.

The body of this report is organized into three main sections: 1. Sample Descriptions, 2. Explanatory notes on the tables, 3. Tables.

SAMPLE DESCRIPTIONS

The descriptions that follow were recorded at the time each sample was received in our laboratory for analysis. Our internal laboratory identification number (SPR followed by a number) was assigned to the sample at that time. Most samples are also labeled by a three part identifier which codes the location from which the sample originated. The first part of the identifier is a two-letter code for the site, the second part is the well number and the third part is the collection depth in feet. Thus, the sample labeled BC-19A-2582 came from a depth of 2582 feet in Bayou Choctaw well 19A. All core samples are primarily halite (NaCl).

Bayou Choctow (BC) Samples

SPR-51 **BC-19A-2582.** 4 inch diameter core, about 10 cm long. Mostly gray in color. Grains generally rounded, 1 to 4 mm • texture looks friable.

SPR-65 BC-l-1219. Brine sample. DOE, Texas Brine, Well #1, Sec. 53 T95 RllE, collected 5/29/80, 11:00 AH. Cylinder about 5 cm OD by about 46 cm long.

SPR-66 BC-4-1003. Brine sample. DOE, Texas Brine, well #4, Sec. 52 T95 RllE, collected 5/29/80, 8:30 AM. Cylinder about 8.9 cm OD by about 25 cm long.

SPR-67 BC-8A-1964. Brine sample. DOE, Texas Brine, Well #8A, collected 5/29/80, 4:00(?)PM. Cylinder about 5 cm OD by 61 cm long.

SPR-74 BC-1-927. Brine sample. Oollected 5/29/80, 10:45 AM. Cylinder about 10 cm OD by 20 cm long.

SPR-75 X-1-1803. Brine sample. Collected 5/29/80, 11:30 AM. Sec. 53 T95 RllE. Cylinder about 5 cm OD by 58 cm long, red and white in color.

SPR-76 BC-1-1511. Brine sample. Collected 5/29/80, 11:50 AM. Sec. 53 T95 RllE. Cylinder about 5 cm OD by 46 cm long, rust brown color.

SPR-77 BC-4-653. Brine sample. Collected 5/29/80. 8:10 AM. Sec. 52 T95 RllE. Cylinder about 8 cm OD by 25 cm long.

SPR-78 BC-4-1353. Brine sample. Collected 5/29/80, 9:00 AM. Sec. 52 T95 RllE. Cylinder about 8 cm OD by 25 cm long.

SPR-79 BC-4-1704. Brine sample. Qllected 5/29/80, 9:15 AM. Sec. 52 T95 RllE. Cylinder about 8 cm OD by 25 cm long.

SPR-80 BC-8A-1419. Brine sample. Qllected 5/29/80, 3:00 PM. Cylinder about 5 cm OD by 58 cm long, rust brown color.

BPR-81 **BC-8A-1692.** Brine sample. Collected 5/29/80, 3:30 PM. Cylinder about 5 cm OD by 58 cm long, white color.

SPR-82 BC-8A-1146. Brine sample. Collected 5/29/80, 2:30 PM. Cylinder about 5 cm OD by 58 cm long, blue color.

SPR-83 BC-19A-2580. 4 inch diameter core, 2 to 3.8 cm thick, one side sawed flat, other side broken. Grain size is several mm, color dark but not black. Fine dark material visible inside some halite grains. Mass about 500 g.

SPR-84 BC-19A-2591. 4 inch diameter core, about 2 to 3.5 cm thick, one end sawed flat, the other end broken, grain size about 5 mm. Color is dark, but not black. Fine grained dark material visible inside most halite grains. Mass about 430 g.

SPR-85 BC-19A-2546? (might be 2596). 4 inch diameter core about 1 to 4 cm thick. Some grain dimensions as large as 2.5 cm. One end sawed flat, other end broken. Dark colored especially in reflected light, lighter in transmitted light. Fine black grains visible inside most halite grains.

SPR-101 BC-20A brine. Dated 4/2/81. Received in plastic "Parson's Sudsy Ammonia" bottle, about 0.4 L volume.

SPR-138 BC-102A. from 7 inch string. Depth 3300 feet. Sample is solid, made up of sand-sized black and white grains. Black grains dominate.

Bryan Mound (BM) Samples

SPR-30 Slab cut from either BM-109B-3244/45 or BM-109B-3247 (SPR-4 or SPR-5 in Reference 1).

The following five samples (SPR-52 through SPR-56) are associated with the oil-brine separator and anhydrite storage pits.

SPR-52 Beach sand In "zip-lock" bag. Sample is damp, gray-brown color, contains some black grains. Taken as a reference background for the anhydrite samples. Mass about 400 g.

SPR-53 Anhydrite + brine from oil-brine separators. Lots of free dirty brown liquid present. "Sand-like" anhydrite material is-gray-brown, individual particles are clear. Some black flakes are present and most (possibly all) of them are magnetic. Mass about 1415 g.

SPR-54 Anhydrite from storage tank. Sample is damp but contains no free liquid. Bulk is colored; Individual grains are white. Labeled "Sample A." Mass about 450 g.

SPR-55 Same as SPR-54 except labeled "Sample B." Mass about 770 g.

SPR-56 Same as SPR-54 except labeled "Sample C." Mass about 1070 g.

SPR-57 Material that came up with leach solution during leaching of BM-110C. Brownish sand-sized grains. Brown seems to be a "mud" stain on clear white grains. Mass about 18 g.

SPR-58 Material that came up with leach solution during leaching of BM-110. Total mass about 6.2 g. Includes black lumps: 1) 1 x 1.5 x 2 cm, black, fine grained, non-magnetic, angular faceted sides, 1.53 g mass. 2) 1 x 1 x 1 cm, black, fine grained, shiny crystal faces on many grains, similar appearance to specular hematite, 0.66 g. 3) ~ 0.8 x 0.8 x 0.8 cm, fine grained, some shiny faces, some pore space, "molten" appearance, 0.22 g. 4) Like previous mass (3) except smaller ~ 0.5 x 0.5 x 0.3 cm, 0.11 g. Remainder of sample is clear white to grayish sand-sited grains and gray lumps about 0.5 to 1 cm across made up of sand-sized grains. A few sand-sized black flakes present.

SPR-63 BM-110A-2684. 4 inch core, 7.5 to 9.5 cm thick, one side is a broken surface, the other side sawed flat. A good bit of mud on the broken surface. Color - white to grayish, grain size about 2 cm at one edge of flat face to about 2 mm at opposite edge. Mass about 1435 g.

SPR-64 BM-110B-3724.5. 4 inch diameter core, 5.4 to 7.6 cm thick. Dark colored halite, one end sawed and flat, one end broken. Grain size 2-5 mm, mass about 1130 g.

SPR-73 BM cavern 2 brine. One liter plastic bottle dated 5/28/80. A little reddish-brown sediment on bottom of the bottle.

SPR-86 BM-110B-3727. 3-1/2 inch diameter core, 9.8 cm thick, both ends sawed flat. One end is dark to a minimum depth of 3.8 cm, with dark color continuing all the way down one side. Remainder is lighter in color, almost white in places. Dark end grain size is 2 to 5 mm and equiaxed. Light end grains are elongated, 2 to 5 mm by 10 to 20 mm is typical. Mass about 1300 g.

SPR-134 Marked "0". Sample from a core sample exposed to saturated brine at 2000 psig for 65 hrs and oil at 2000 psig for 49 hrs. Sample is brownish-gray, contains some multicrystalline flakes. Multicrystalline flakes cemented by water soluble material, probably NaCl.

SPR-135 Marked "00". Sample from a core exposed to oil at 2000 psig for 46 hrs. Sample is medium to dark brown grains matted together, presumably by oil.

SPR-136 Oil used to Pressurize samples SPR-134 and SPR-135. Crude Type 1 as is stored at BM.

SPR-137 Brine line residue. Sample ~ 9 mm thick with parallel 1 to 2 mm thick alternating brown and white bands. Some clear halite crystals on surface.

Sulfur Mines (SM) Samples

Some Sulfur Mines samples were received with the name Sulfur Dome applied to them. Sulfur Mines and Sulfur Dome are the same site and Sulfur Wines is the proper name of the site. The sample names listed below, however, are the names as they were listed on the samples at the time they were received.

SPR-102 SM-6Y-3220. Brine sample. 2/11/81. Cylinder DOT-3A8100 W1A 7534 Whitey 6EK079 - 1000 cc.

SPR-103 SM-6Y-3270. Brine sample. 2/11/81. Cylinder DOT-3A1800 W1A-7571 Whitey 6EK079 - 1000 cc.

SPR-104 SM-6Y-3340.. Brine sample. Cylinder DOT-3A1800 W1A-7543 Whitey 6EK079 1000 cc.

SPR-105 SM-6Y-2950. Brine sample. 2/11/81. 122 cm long cylinder. 99954436-l 504L ASTM A312 ASME SA312 GR. TP304 NB2-1/2 X SCH40S Heat No. AO-40101.

SPR-106 SM-6Y-3090. Brine sample. 2/11/81. 122 cm long cylinder 9954436-l 21/2 40s. Other nomenclature on cylinder is the same as on SPR-105.

SPR-107 SM-6Y-3030. Brine sample. 2/11/81. 122 cm long cylinder. 21/2 40s WP 304L BENKAN. Other nomenclature on cylinder same as on SPR-105.

SPR-108 SM-6Y-3140. Brine sample. 2/11/81. 122 cm long cylinder. Nomenclature on cylinder is the same as on SPR-107.

SPR-109 SD-2A-2450. Brine sample in 500 mL polyethylene bottle. 6/11/81. Brine looks fairly clean, some salt precipitate present in the bottle.

BPR-110 SD-2A-2500. Brine sample in 500 mL polyethylene bottle. 6/11/81. Solution looks clean, some salt precipitate present in the bottle.

SPR-111 SD-2A-2750. Brine sample in 500 mL polyethylene bottle. 6/11/81. Solution looks clean but oil stain covers most of the inside surface of the bottle. Some salt precipitate present in the bottle.

SPR-112 SD-ZA-2965. Brine sample in 500 mL polyethylene bottle. Looks the same as SPR-111.

Samples SPR-119 thru SPR-133 were received in 1 L plastic bottles. Some oil was present in all bottles, either as scum on surface of brine or on bottle walls.

SPR-119 SM-7C-2950. Brine sample. 6/15/81. 1.6 cm head space, some salt crystals present.

SPR-121 SM-7C-3090. Brine sample. 6/15/81. 0.6 cm head space, some salt crystals present.

SPR-122 SM-7C-3140. Brine sample. 6/15/81. 1.9 cm head space, some salt crystals present.

SPR-123 SM-7C-3220. Brine sample. 6/15/81. 0.6 cm head space, some sediment present but no salt crystals seen.

SPR-124 SM-7C-3270. Brine sample. 6/15/81. No head space, some sediment present but no salt crystals seen.

SPR-125 SM-7C-3340. Brine sample. 6/15/81. 0.3 cm head space, lots Of crystals present.

SPR-126 SM-7C-2860. Brine sample. 6/22/81. 1.4 cm head space, some sediment present but no salt crystals seen.

SPR-127 SM-7C-2945. Brine sample. 6/22/81. 2.1 cm head space, some sediment present but no salt crystals seen. Cap on bottle was loose when received, a salt crust was present around cap.

SPR-128 SM-7C-3030. Brine sample. 6/22/81. 1 cm head space, brown sediment present but no salt crystals seen. No oil present on top of this sample.

SPR-129 SM-7C-3130. Brine sample. 6/22/81. 1 cm head space, brown sediment present but no salt crystals seen. No oil present on top of this sample.

SPR-130 SM-4-2700. Brine sample. 7/29/81. 1.9 cm head space, salt crystals present.

SPR-131 SM-4-2800. Brine sample. 7/29/81. 4.6 cm head space, salt crystals present.

SPR-132 SM-4-2900. Brine sample. 7/29/81. 4.8 cm head space. Small amount of salt crystals present.

SPR-133 *SM-4-3000.* Brine sample. 7/29/81. 4.1 cm head space. Small amount of salt crystals present.

Weeks Island (WI) Samples

SPR-27 From Ventilation By-pass drift about 370 feet (113 m) below sea level. Multicrystalline mass about 3 x 5 x 6 cm. Crystals are about 1 cm and less across. Crystals are clear with dirt on some faces. Dirty crust on one side of the sample. Mass about 95.4 g.

SPR-28 Same source as SPR-27. Sample is a plastic bag of crystal fragments. The largest are about 1 x 2 x 3 cm, others are about 1 cm to 3 mm across. All are clear white, some have dirt on some surfaces. Mass about 28.3 g.

SPR-29 Same source as SPR-27. Bag of stalactite-like material that formed in the drift. Some pieces white, others dirty-gray. Fine-grained (< 0.3 mm), translucent to opaque. Probably a secondary formation due to mining operations. Mass about 14.8 g.

SPR-139 Diamond Drift, PS, 8/4/82. White to clear salt, cm grain size, friable, black to gray foreign substance (diesel exhaust?) on many surfaces.

SPR-140 Markel Mine, A-l, 8/4/82. Mostly salt, cm + grain size crushed in places to powder-sized fragments. Appears foliated. Black deposit (diesel fuel or exhaust?,) on one side, brownish yellow stain on other side. Sample mechanically much stronger than SPR-139.

SPR-141 Wet Drift, WD-2, 8/4/82. Bag of crystals, fragments and fines < 1 cm across to dust. Some fragments white to gray, others yellow to yellow brown. Sample probably contains some chemical grout.

West Hackberry (WH) Samples

SPR-1 WH-6C-2208. A slice of 4 inch (8.3 cm) diameter core ranging from about 1/2 to 1-3/8 inches (1.3 to 3.5 cm) thick. Color - clear white. Grain size ~ 0.4 inch (1 cm). Weight - 385 g.

SPR-2 WH-6C-2241/3. A slice of 3-1/4 inch (8.3 cm) diameter core ~ inches (5 cm) thick. Color - mostly clear white, perhaps slightly darker than SPR-1. Grain size - ~ 0.4 inch (1 cm). Weight - 591 g.

SPR-3 WH-6C-2208. A slice of 4 Inch (10.2 cm) diameter core ranging from 7/8 to 1-3/4 inch (2.2 to 4.4. cm) thick. Cut from same 1 foot section of core as SPR-1. Color - mostly white and clear, but has some dark streaks running through it. Weight - 601 g.

SPR-31 WH-6B-2835. Sidewall sample in plastic bottle; sample has been in contact with oil. Approximately 3/4 inch (1.9 cm) diameter by 3/4 inch (1.9 cm) long. Soft, fine grained material 4-5 mm thick on one end. Lots of dark color penetrating along halite grain boundaries.

SPR-32 WH-6B-3150. Sidewall sample in plastic bottle; sample has been in contact with oil. Approximately 3/4 inch (1.9 cm) diameter by 3/4 inch (1.9 cm) long. Muddy brown color, soft, fine grained material for 4-5 mm on one end, large NaCl grains on other end. Apparently much oil penetration along grain boundaries.

SPR-33 WH-6C-3170. Sidewall sample in plastic bottle; three individual pieces. Sample has been in contact with oil, but shows little sign of oil penetration. Pieces are mostly white in color and are much whiter than SPR-31 and 32. Some soft, fine grained material on one end.

SPR-34 **WH-6C-3213.** Sidewall sample in plastic bottle; sample has been in contact with oil. Approximately **3/4** inch (1.9 cm) diameter by **3/4** inch (1.9 cm) long. Sample is mostly white (like SPR-33) with some dirty brown-colored material (oil?) along some internal grain boundaries. Halite grain size - up to 0.4 inch (1 cm). Soft, fine **grained** material on one end.

SPR-35 WH-6C-3216. Sidewall sample in plastic bottle, highly fragmented. Sample has been in contact with oil.

SPR-36 WH-6B-2730. Sidewall sample in plastic bottle, fragmented. Sample has been in contact with oil.

SPR-37 **WH-6B-3181.** Sidewall ● ampla in plastic bottle, fragmented. **Sample has** beta in contact **with** oil.

SPR-38 **WH-6B-3270. Brine** in 1 littr sttl cylinder. Qlltcttd **3/19/80** at **9:00 AM.** Collection temperature ● □□□ **100°F.**

SPR-39 **WH-6B-3310. Brine** in 1 littr steel cylinder. Qlltcttd **3/19/80** at **9:45** AM. Collection **temperature approx.100°F.**

SPR-40 **WH-6B-3350. Brine** in 1 liter **steel** cylinder. **Collected 3/19/80 at 10:15 AM.** Collection ttmperaturt **approx.100°F.**

SPR-41 **WH-6B-3370. Brine** in 1 liter ttttl cylinder. **Collected 3/19/80** at **10:20** AM. Collection temperature ● pproc. **100°F.**

SPR-42 **WH-6C-3275. Brine** in 1 littr rttel cylinder. **Collected 3/22/80** at **8:45** AM. Collection ttmptraturt ● ppro#. **100°F.**

SPR-43 **WH-6C-3310.** Brine in 1 liter rtttl cylinder. Collected **3/22/80** at **9:15** AM. Collection temperature ● pprox. **100°F.**

SPR-44 **WH-6C-3345.** Brine in 1 liter steel cylinder. Collected **3/22/80** at **9:45** AM. Collection temperature ● *pprox.* **100°F.**

SPR-45 **WH-6C-3380.** Brine in 1 liter rteel cylinder. Collected **3/22/80** at **10:30** AM. Collection temperature ● pprox. **100°F.**

SPR-46 **WH-6B-3030. Sidewall sample** in plastic bottle. Approx. **3/4** inch (1.9 **cm) diameter** by **3/4** inch (1.9 cm) long. Color - **very dark** to black, probably due to oil penetration. Grain ● fze ● pprox. 0.4 inch **(1** cm). Sane areas **soft** and fine **grained.**

SPR-47 **WH-6B-2921.** Sidewall sample in **plastic** bottle. Approx. **3/4** inch (1.9 cm) diameter by **3/4** inch (1.9 cm) long. Color - **very dark** in ● ome regions, probably due to oil penetration *and* white to clear in other regions. Grain **size-** ● pprox. 0.4 inch **(1** cm). Puts fine graintd and ● *oft.*

SPR-48 WH-6C-3 188. Sidewall sample in plastic bottle. Approx. 3/4 inch (1.9 cm). diameter by 3/4 inch (1.9 cm). long. Color - mostly white, small amount of dark material (oil?) on some *grain* boundaries.. *Grain* size - pprox. 0.4 inch (1 cm).

SPR-49 WH-6C-3208. Sidewall sample in *plastic* bottle. Approx. 3/4 inch (1.9 cm) *diameter* by 3/4 inch (1.9 cm) long. Color - mostly white, some *dark* material (oil?) penetrating grain boundaries near edges. Grain size - pprox. 0.4 inch (1 cm).

SPR-50 WH-6B-2730. Sidewall sample in plastic bottle. Approx. 3/4 inch (1.9 cm) *diameter* by 3/4 inch (1.9 cm) long. Color - very dark to black, probably due to oil penetration. Grain size - pprox. 0.4 *inch* (1 cm). Some areas soft and fine grained.

SPR-59 WH-108-2244. A piece of 4 inch (10.2 cm) diameter core, *one* end sawed the other irregular. Color - grayish to clear. Halite contains cloudy areas, rpots and inclusions, probably anhydrite. Crystal size at least several inches (5 to 10 cm or more). Weight 474 g.

,PR-60 WH-108-2267. A piece of 4 inch (10.2 cm) diameter core, not a complete cross-section. One end was sawed, the other end irregular broken surface. Color - clear halite with a grayish cast. Many small inclusions (anhydrite?) seen In the halite. Grain size - about the same as the diameter of the core. Weight - 545 g.

SPR-61 WH-108-3651.5. A piece of 4 Inch (10.2 cm) diameter core. One end sawed, the other irregular and broken. Some clear halite, and some halite containing dark opaque inclusions. Halite grain size - several inches (5 to 10 cm). Weight 597 g.

SPR-62 WH-108-3670. A piece of 4 inch (10.2 cm) diameter core. One end sawed, the other broken. Color - clear, very white halite. Contains some small, clear inclusions (anhydrite?) Grain size - entire sample may be part of one crystal. Weight - 656 g.

SPR-68 WH-6-326 5. Brine in 1 liter steel cylinder. Pod #6, well #6, slick hole depth 3265 *ft* @ port, collected 5/4/80. A lot of dried salt around one valve and a lot of void space in the cylinder - perhaps there had been some leakage. Brown and white cylinder.

SPR-69 WH-6-3325. Brine in 1 liter steel cylinder. Pad #6, well #6, slick hole 3325 ft @ port, collected 5/4/80. Blue cylinder.

SPR-7 0 WH-6-3355. Brine in liter steel cylinder. Pad #6, well #6, slick hole 3355 ft @ port, collected 5/4/80. Some salt caked around one valve, white cylinder.

SPR-7 1 WH-6-3385. Brine in 1 liter steel cylinder. Pad #6, well #6, slick hole 3355 ft @ port, collected 5/4/80. Red and brown cylinder.

SPR-72 WH-6. Crude oil. Metal can, 1/2 gal. of crude oil that had been pumped out of well #6.

SPR-87 WH-102-2263/2268. A piece of core about 10 inches (25 cm) long, sides badly eroded. Original diameter probably 3-1/2 to 4 inches (8.9 or 10.2 cm). Now consists of a central halite core about 2-1/2 inches (6.4 cm) in diameter which has a smooth glassy surface - as If "polished" by partial dissolution. Irregular inch sized (2 to 3 cm) inclusions of a fine grained, grayish material (anhydrite?) are set in the halite and in many cases protrude from the halite. Looks like core may have been exposed to running water.

SPR-88 WH-6-3265. Brine in 1 gallon (3.8 liter) steel cylinder. Run #4, collected 9/23/80. Approx. 1 inch (2.5 cm) valve fittings. Cylinder inscribed: Whftey 1EK080 304L-HDF8- 1 Gal. DOT-3A1800 W3A3548.

SPR-89 WH-6-3385. Brine in 1 gallon (3.8 liter) steel cylinder. Run #1, collected 9/22/80. Approx. 1 Inch (2.5 cm) valve fittings. Cylinder inscribed: Whitey 1EK080 304L-HDF8 - 1 Gal. DOT-3A1800 W3A3359.

SPR-90 WH-6-3355. Brine in 1 gallon (3.8 liter) steel cylinder. Run #2, collected 9/23/80. Approx. 1 inch (2.5 cm) valve fittings. Cylinder inscribed: Whitey 1EK080 304L-HDF8 - 1 Gal. DOT-3A1800 W3A3450.

SPR-91 WH-6-3325. Brine in 1 gallon (3.8 liter) steel cylinder. Run #3, collected 9/23/80. Aprox. 1/2 inch (1.3 cm) valve fittings. Cylinder Inscribed: Whitey 1EK080 304L-HDF4 - 1 Gal DOT-3A1800 W3A3854.

SPR-92 WE-6-3265. Brine sample in four connected 75 cm^3 steel cylinders. Run #1, collected 10/14/80. All 4 cylinders inscribed: 75cc, DOT-3E1800 Whitey. Individual inscriptions: 12EK078; 5EK078; llEK079 304L-HDF4; 12EK078.

SPR-93 WH-6-3325. Brine sample in four connected 75 cm^3 steel cylinders. Run #2, collected 10/14/80. Inscription on each of the 4 cylinders: Whitey llEK079 304L-HDF4-75cc DOT-3E1800.

SPR-94 WH-6-3355. Brine sample in four connected 75 cm^3 steel cylinders. Run #3, collected 10/14/80. Inscription on each of the three cylinders: Whitey llEK079 304L-HDF4-75cc DOT-3E1800. Inscription on fourth cylinder: Whitey 12EK78 75cc DOT-3E1800.

SPR-95 WR-6-3375. Brine sample in three connected 75 cm^3 steel cylinders. Run #4, collected 10/14/80. Inscription on each of the three cylinders: Whitey llEK079 304L-HDF4-75cc DOT-3E1800.

SPR-96 **WH-114-3693.** A piece of 5 inch (12.7 cm) core. Sample is a fragment about 4.7 x 3.9 x 1.6 inches (12 x 10 x 4 cm) in size. Color - mostly white, fairly clear halite; some brownish gray color. Grain size - about 0.4 x 0.8 inch (1 x 2 cm), elongated in a direction about parallel to core axis. Box core was shipped in was labeled well 119 rather than well 114.

SPR-97 **WH-102-3665.5.** A piece of 4 inch (10.2 cm) diameter core ranging from 0.8 to 2.4 inches (2 to 6 cm) thick. One end sawed, the other end broken. Color - mostly white, fairly clear halite, a little brownish color. Grain size - large; largest is > 2.4 inches (6 cm) across.

SPR-9 8 **WH-107-2436.** A piece of 4 inch (10.2 cm) diameter core ranging from 1.2 to 1.6 inches (3 to 4 cm) thick. One end sawed, the other broken. Color - mostly white, fairly clear halite, a little brownish gray color. Grain size - large; largest is > 2.4 inches (6 cm) across. Section contains some fine grained inclusions (anhydrite?) about 0.5 inch (1 to 1.5 cm) across.

SPR-99 WH-113-23 57. A piece of 4 inch (10.2 cm) diameter core ranging from 1 to 2.4 Inches (2.5 to 6 cm) thick. One end sawed, the other broken. Color - mostly white, fairly clear halite; a little brownish gray color present. Grain size - 0.4 to 0.8 inches (1 to 2 cm).

SPR-100 WH-113-2742. A piece of 4 inch (10.2 cm) diameter core ranging from 0.8 to 1.4 inches (2.5 to 3.5 cm) In thickness. One end sawed, the other broken. Color - mostly white, fairly clear halite; a little brownish gray color present. Grain size - 0.4 to 0.8 inch (1 to 2 cm) typically. A large, opaque fine-grained inclusion (anhydrite?) 0.4 x 1 x 1.2 Inch (1 x 2.5 x 3 cm) seen near one edge of the core.'

EXPLANATORY NOTES ON TABLES

Table 1. Densities of Bayou Choctaw, Bryan Mound and West Hackberry salt samples

Results of two different methods of density determination are listed. Details of the air comparison pycnometer method are in Reference 1 while the liquid (ethanol) displacement method was developed specifically for these samples. As indicated in the table, the liquid displacement method is significantly more precise than the air pycnometer. Pure halite has a density of 2.16 g/cm^3, pure anhydrite has a density of 3.0 g/cm^3.

Table 2. Chemical composition of Bayou Choctaw core samples

Analysis is performed by dissolving a known mass of core in de-ionized water and filtering the solution from the insoluble residue. The solution is analyzed for the dissolved anions and cations shown in the table. The insoluble residue is dried, weighed and identified by x-ray diffraction and optical methods. In all cases so far, the insoluble residue has been made up of only anhydrite (CaS04) and the Ca^{++} and $SO_4^{=}$ can be assumed to be a small amount of anhydrite that dissolved. The exact amount of anhydrite that dissolved for a particular sample is dependent on the dissolution conditions used for that sample. The Ca^{++} and $SO_4^{=}$ concentrations by themselves have little value; the significant value for Ca and SO4 is the "total CaS04" column. Details of analytical methods are in Reference 1. The only significant change from Reference 1 is that Cl' and $SO_4^{=}$ analyses are now usually done by ion chromatography. Unless other values are given in the table, estimates of analytical uncertainties for this and all other chemical analyses in this report are ± 1% relative for wt.% insolubles, ± 2% relative for Na^{+} and Cl', ± 5% relative for Ca^{++} and $SO_4^{=}$, and ± 10% relative for Mg^{++}.

Table 3. Chemical composition of the water soluble fraction of Bayou Choctaw core in molar units

The values in this table are calculated from the data in the previous table. Note that moles of Ca^{++} and moles of $SO_4^{=}$ agree very well, consistent with the assumption that all Ca^{++} and $SO_4^{=}$ is the result of dissolving anhydrite.

Table 4. Chemical composition of Bryan Mound core samples

See discussion of Table 2 above. Additional analyses of Bryan Mound core may be found in Reference 1.

Table 5. Chemical compositions of the water soluble fraction of Bryan Mound core in molar units

See discussion of Table 3 above.

Table 6. Chemical compositions of West Hackberry core samples

See discussion of Table 2 above.

Table 7. Chemical compositions of the water soluble fraction of West Hackberry core in molar units

See discussion of Table 3 above. Note that the two SPR-87 samples contain significantly more $SO_4^{=}$ than Ca^{++}, indicating that a small amount of a second $SO_4^{=}$ mineral is probably present.

Table 8. Results of x-ray diffraction analysis of Bayou Choctaw samples

Note that the report of a small amount of nitrobarite in the SPR-51 water insoluble fraction could not be reproduced and is probably erroneous. Samples identified as "handpicked" in the description column were a very small fraction(<1%) of the total insoluble material.

Table 9. Results of x-ray diffraction analysis of Bryan Mound samples

See sample description section of this report for additional information on samples.

Table 10. Results of x-ray diffraction analysis of Weeks Island samples

The light amorphous water insoluble material from SPR-141 floated in water and is probably a chemical grout.

Table 11. Minerals detected in West Hackberry core samples by x-ray diffraction

Self-explanatory.

Table 12. Minerals detected in water insoluble residue of West Hackberry core by x-ray diffraction

Samples labeled as "handpicked grains" in the Notes column were a very small fraction (<1%) of the total insoluble material.

Table 13. Hydrogen and carbon contents of West Hackberry sidewall samples

The sum of H and C for each of these samples is an estimate of the amount of oil trapped in cracks in each sample.

Table 14. Compositions and densities of Bayou Choctaw brine samples

Methods of analysis were the same as those used for analyzing the solutions produced during analysis of core samples (see Reference 1 and the discussion of Table 2 above). The pH values in the table were measured in the lab by pH meter several weeks to months after sample collection. Since pH is often not stable during sample storage, the values reported may have little relation to the pH of the brine in the cavern at collection time.

Table 15. Composition of Bayou Choctaw brines in molar units

Chemical data from the previous table recalculated in molar units. Note that in several cases the moles of Ca^{++} and moles of $SO_4^{=}$ differ by significant amounts. This means that the Ca^{++} and $SO_4^{=}$ in these brines cannot be attributed to only dissolution of anhydrite.

Table 16. Compositions and densities of Sulfur Mines brine samples

See comments above on Table 13.

Table 17. Composition of Sulfur Mines brines in molar units

See comments above on Table 15.

Table 18. Concentrations of NO_3^- and $PO_4^{\equiv}$ in four Sulfur Mines brines

These analyses were done by ion chromatography.

Table 19. Compositions and densities of West Hackberry brine samples

The purpose of these analyses was to measure the degree of saturation of these samples. Since the necessary information could be calculated from Cl- and $SO4^{=}$, only Cl- and $SO4^{=}$ were determined for the sample. Fe concentration was also determined in four of the samples.

Table 20. Compositions of West Hackberry brine samples in molar units

Data from previous table recalculated in molar units.

Table 21. Results of analyses of residue from West Hackberry brines, of a West Hackberry sidewall sample for oil, and of a Bryan Mound brine for Ag and Au; and results of a qualitative x-ray fluorescence analysis of West Hackberry core samples

Self-explanatory.

Table 22. Analysis of water insoluble residue from oil treated Bryan Mound core

Samples from a test to determine the amount of oil that would be trapped in cavern walls. See sample description section for additional sample history. Halite in the sample is probably the result of incomplete dissolution and washing.

Table 23. Results of analyses of Bryan Mound anhydrite "sand" and beach sand leachates

Samples were leached in the lab with deionized water until the fluid coming off of the "sand" tested free of Cl'. pH is the pH of all leach fluid from the sample measured immediately after leaching. Void volume was determined by ethanol displacement.

Table 24. Saturated solution of NaCl in water expressed in various units and in terms of NaCl, Na^+ and Cl' concentrations at 20°C

Results of analyses of NaCl solutions can be reported in many forms and units. This table provides a means of comparing these methods of reporting and of calculating % saturation from them.

Table 25. Densities of solutions of salts

This table is provided for reference and for the comparison with densities determined for SPR brines.

Table 1. Densities of Bryan Mound, Bayou Choctaw and West Hackberry Salt Samples by Liquid Displacement and Air Comparison Pychometer

Sample*		Liquid Displacement (g/cm^3)	Air Comparison Pychometer (g/cm^3)
SPR-21	BM-107C-2503	2.17 ± 0.02	2.17 ± 0.05
SPR-23	BM-108B-3316	2.20 ± 0.02	2.16 ± 0.05
SPR-24	BM-108B-3332	2.19 ± 0.02	2.17 ± 0.05
SPR-63	BM-110A-2684	2.18 ± 0.02	
SPR-64	BM-110B-3724.5	2.20 ± 0.02	
SPR-51	BC-19A-2582	2.18 ± 0.02	-
SPR-31	WH-6B-2835	-	2.16 ± 0.05
SPR-32	WH-6B-3150	-	2.14 ± 0.05
SPR-33	WH-6C-3170	-	2.14 ± 0.05
SPR-34	WH-6C-3213	-	2.16 ± 0.05
SPR-59	WH-108-2244	2.18 ± 0.02	-
SPR-60	WH-108-2267	2.17 ± 0.02	-
SPR-61	WH-108-3651.5	2.18 ± 0.02	-
SPR-62	WH-108-3670	2.17 ± 0.02	-

*SPR-31, 32, 33, 34 are sidewall samples, all others are core samples.

Table 2. Chemical Compositions of Bayou Choctaw Salt Core Samples. All values are wt.%.

Sample		Soluble Na^+	Soluble Ca^{++}	Soluble K^+	Soluble Cl^-	Soluble $SO_4^=$	Insoluble*	Sum	Total† $CaSO_4$
SPR-83	BC-19A-2580	38.1	0.056	0.0054	59.6	0.14	1.86	99.76	z-06
SPR-84	BC-19A-2591	38.6	0,080	0.0044	59.2	0.20	2.36	98,08	2.64
SPR-85	BC-19A-2546	38.0	0,089	0,0086	59.6	0.22	1.79	99.71	2.10

Other results - SPR 83, 84, 85 HCO_3^-, $CO_3^= \leq 0.005$ wt.%
SPR 83, 84 $Mg^{++} \leq 0.001$ wt.%
SPR 85 $Mg^{++} = 0,001$ wt.%

*In all cases insoluble residue in anhydrite (ε0S0/ɟ) is dependent on dissolution conditions. ● Amount which dissolved to Ca^{++} and $SO_4^=$

†Sum of insoluble + Ca^{++} + $SO_4^=$.

Table 3. Chemical Compositions of the Water Soluble Fractions of Bayou Choctaw Core in Molar Units. All values are moles per 100 g of bulk core.

Sample		Na^+	Ca^{++}	K^+	$SO_4^=$
SPR-83	BC-19A-2580	1.66	0.0014	1.4×10^{-4}	0.0015
SPR-84	BC-19A-2591	1.68	0.0020	1.1×10^{-4}	0,00Z1
SPR-85	BC-19A-2546	1.65	0.0022	2.2×10^{-4}	0.0023

Table 4. Chemical compositions of Bryan Mound Salt Core Samples
All values are in wt.%.

Sample		Soluble Na^+	Soluble Ca^{++}	Soluble K^+	Soluble Cl^-	Soluble $SO_4^=$	Insoluble*	Sum	Total† $CaSO_4$
SPR-63	BM-110A-2684	38.3	0.117	0.023	58.0	0.29	3.50	100.23	3.91
SPR-64	BM-110B-3724.5	36.1	0.463	0.023	55.9	1.27	5.72	99.48	7.45
SPR-86	BM-110B-3727	36.4	0.[illegible]	0.031	56.8	0.80	5.30	99.65	6.42

Other results - SPR-63,64 $Mg^{++} \leq 0.001$ wt.%; HCO_3^-, $CO_3^=$ $\leq$ 0.00S wt.%
SPR-86 $Mg^{++} = 0.001$ wt.%; HCO_3^-, $CO_3^=$ $\leq$ 0.00S wt.%
SPR-87 Coarse & Fine $Mg^{++} \leq 0.001$ wt.%; HCO_3^-, $CO_3^=$ $\leq$ 0.00S wt.%

*In all cases insoluble residue is anhydrite ($CaSO_4$). Amount which dissolved to Ca^{++} and $SO_4^=$ is dependent on dissolution conditions.

†Sum of Insoluble + Ca^{++} [illegible]

Table 5. Chemical Compositions of Water Soluble Fractions of Bryan Mound Core in Molar Units. All values are moles per 100 g of bulk core.

Sample		Na^+	Ca^{++}	K^+	Cl^-	$SO_4^=$
SPR-63	BM-110A-2684	1.67	0.0029	5.9×10^4	1.64	0.0030
SPR-64	BM-110B-3724.5	1.57	0.012	5.9×10^4	1.58	0.013
SPR-86	BM-110B-3727	1.58	[illegible] 0080	7.9×10^4	1.60	0.0083

Table 6. Chemical Compositions of West Hackberry Salt Core Samples
All values are in wt.%.

Sample		Soluble Na^+	Soluble Ca^{++}	Soluble K^+	Soluble Cl^-	Soluble $SO_4^=$	Insoluble*	Sum	Total† $CaSO_4$
SPR-1	WH-6C-2208	37.7	0.27	[illegible]	58.5	0.65	1.87	98.99	2.79
SPR-2	WH-6C-2241/3	37.5	0.27	0.001	57.9	0.66	2.54	98.87	3.47
SPR-3	WH-6C-2208	36.5	0.36	0.001	57.4	0.86	0.90	99.02	5.12
SPR-59	WH-108-2244	39.1	0.17	0.0011	59.0	0.44	2.12	100.83	2.72
SPR-60	WH-108-2267	98.8	0.12	[illegible]	59.6	0.30	1.47	100.29	1.89
SPR-61	WH-108-3651.5	36.6	0.38	0.0010	56.5	0.94	5.62	100.04	6.94
SPR-62	WH-108-3670	39.7	0.047	0.0010	60.3	0.11	0.09	100.25	0.25
SPR-87	WH-102-2263/ 2268 Coarse	38.2	0.087	0.002	58.3	0.40	3.75	100.74	4.23
SPR-87	WH-102-2263/ 2268 Fine	8.72	0.38	0.009	13.8	1.77	74.7	99.37	76.9
SPR-96	WH-114-3693	38.5	0.49	0.0018	57.8	1.09	0.43	98.31	2.01
SPR-97	WH-102-3665.5	37.9	0.42	0.0012	59.0	0.95	0.90	99.17	2.27
SPR-98	WH-107-2436	34.9	0.47	0.0008	53.2	1.12	9.80	99.49	11.39
SPR-99	WH-113-2357	36.8	0.41	[illegible] 0009	56.2	0.93	5.76	100.10	7.10
SPR-100	WH-113-2742	38.3	0.51	0.0012	58.7	1.19	0.97	99.67	2.67

Other results - all samples: $HCO_3^=$, CO_3 < 0.005 wt.%
SPR 59-62 and SPR 96-100: $Mg^{++} \leq 0.001$ wt.%
SPR 2,3: $Br^- \leq 0.005$ wt.%
SPR 1-3: Li^+ and $Sr^{++} \leq 0.001$ wt.%, smelled of H_2S during [illegible]

*In all cases insoluble residue is anhydrite (CaSO4). Amount which dissolved to Ca^{++} + $SO_4^=$ is dependent on dissolution conditions.

†Sum of Insoluble + Ca^{++} + $SO_4^=$.

Table 7. Chemical Compositions of Water Soluble Fractions of West Hackberry Core in Molar Units. All values are moles per 100 g of bulk core.

Sample		Na^+	Ca^{++}	K^+	Cl^-	$SO_4^=$
SPR-1	WH-6C-2208	1.64	0.0068	0.00003	1.65	0.0068
SPR-2	WH-6C-2241/3	1.63	0.0068	0.00003	1.63	0.0069
SPR-3	WH-6C-2208	1.59	0.0090	0.00003	1.62	0.0090
SPR-59	m-108-2244	1.70	0.0042	0.00003	1.66	0.0046
SPR-60	m-108-2267	1.69	0.0029	0.00003	1.68	0.0031
SPR-61	W-l-108-3651.5	1.59	0.0095	0.00003	1.59	0.0098
SPR-62	WH-108-3670	1.73	0.0012	0.00003	1.70	0.0012
SPR-87	WH-102-2263/ 2268 Coarse	1.66	0.0021	0.00005	1.64	0.0042
SPR-87	WH-102-2263/ 2268 Fine	0.379	0.0095	0.00002	0.389	0.018
SPR-96	WI-I-114-3693	1.67	0.0122	0.00005	1.63	0.0114
SPR-97	WH-102-3665.5	1.65	0.0105	0.00003	1.66	0.0099
SPR-98	WH-107-2436	1.52	0.0017	0.00002	1.50	0.0117
SPR-99	WH-113-2357	1.60	0.0102	0.00002	1.59	0.0097
SPR-100	WH-113-2742	1.67	0.0127	0.00003	1.66	0.0124

Table 8. Results of X-Ray Diffraction Analysis of Bayou Choctaw Samples

Sample		Description	Major	Others, notes
SPR-51	BC-19A-2582	Water insoluble fraction	Anhydrite	1 weak line, possible calcite.
SPR-51	BC-19A-2582	Non-anhydrite grains handpicked from water insoluble fraction	(Nitrobarite)	Additional analyses could not confirm nitrobarite, this identification is probably erroneous. (See next sample).
SPR-51	BC-19A-2582	Non-anhydrite grains handpicked from water insoluble fraction. Repeat of above analysis.	Dolomite	Possible calcite. No nitrobarite Contaminated with anhydrite
SPR-138	BC-102A-3300	Bulk sample	Halite, Magnetite	

Table 9. Results of X-Ray Diffraction Analysis of Various Samples from Bryan Mound

Sample		Description	Major Minerals	Other
SPR-53		Anhydrite and brine from oil-brine separator	Anhydrite	Halite (trace) Broad weak peak at ~ 7 Å (possible clay)
SPR-55		Anhydrite "sand" from storage tank.	Anhydrite	Possibly a trace of gypsum; broad weak peak at ~ 7 Å (possible clay)
SPR-57	BM-110C	Homogeneous "sand" washed from drill hole during	Anhydrite	
SPR-58	BM-110A	"Sand", gray lumps and black lumps washed from drill hole during leaching.	Sand-Anhydrite Gray lump-anhydrite Small black lump - Dolomite Large black lump - Quartz, Dolomite	- - Possible quartz Probable sanidine and muskovite with trace of a clay (montmorillonite).
SPR-137	BM	Deposit from inside brine line	Vaterite (polymorph of $CaCO_3$)	Halite, an iron compound (probably an oxide), possible quartz; possible sulfur or sulfur compound

Table 10. Results of X-Ray Diffraction Analysis of Weeks Island Samples

Sample	Description	Major	Other
SPR-27	Water insoluble	Anhydrite	-
SPR-29	Bulk sample	Halite	Trace calcite
SPR-139	Bulk sample	Halite	-
SPR-139	Water insoluble	Anhydrite	-
SPR-140	Bulk	Halite	Chemical analysis of yellow stain on surface detected iron
SPR-140	Water insoluble	Anhydrite	-
SPR-141	Bulk	Halite	-
SPR-141	Water insoluble (heavy)	Anhydrite	-
SPR-141	Water insoluble (floats)	Amorphous	-

Table 11. Minerals Detected in West Hackberry Core Sample by X-Ray Diffraction

Sample		Major	Minor	Notes
SPR-1	WH-6C-2208	Halite	Anhydrite	
SPR-2	WH-6C-2241/3	Halite	Anhydrite	
SPR-3	WH-6C-2208	Halite	Anhydrite	
SPR-35	WH-6C-3216	Halite	Anhydrite	
SPR-36	WH-6B-2730	Halite	-	
SPR-37	WH-6B-3181	Halite	-	
SPR-87	WH-102-2263/ 2268 Fine	Anhydrite, Halite	-	Fine grained regions
SPR-87	WH-102-2463/ 2268 Coarse	Halite	Anhydrite possible trace dolomite	Coarse, clear salt regions
SPR-96	WH-114-3693	Halite	-	
SPR-98	WH-107-2436	Halite, Anhydrite	Extra very weak line at 2.10 Å.	Sample is inclusion from bulk core.
SPR-100	WH-113-2742	Halite, Anhydrite	-	Sample is inclusion from bulk core.

Table 12. Minerals Detected in Water Insoluble Residue of West Hackberry Core by X-Ray Diffraction

Sample		Major	Other	Notes
SPR-1	WH-6C-2208	Anhydrite	Possible trace dolomite?	
SPR-2	WH-6C-2241/3	Anhydrite	Possible trace dolomite?	
SPR-3	WH-6C-2208	Anhydrite		
SPR-35	WH-6C-3216	Anhydrite		
SPR-59	WH-108-2244	Dolomite	Minor anhydrite	Unusual grains handpicked from bulk of residue
SPR-60	WH-108-2267	Dolomite	Minor anhydrite	Unusual grains handpicked from bulk of residue
SPR-61	WH-108-3651.5	Anhydrite‘	1 extra weak line	
SPR-64	WH-110B-3724.5	Anhydrite	2 extra weak lines possible dolomite?	

Table 13. Hydrogen and Carbon Contents of West Hackberry Sidewall Samples

Sample			H (wt.%)	C (wt.%)	H/C molar
SPR-31	WH-6B-2835	Run 1	0.06	0.29	
		Run 2	0.05	0.28	
		Average	0.06	0.28	2.20
SPR-32	WH-6B-3150	Run 1	0.05	0.18	
		Run 2	0.04	0.15	
		Run 3	0.03	0.15	
		Average,	0.04	0.16	2.24
SPR-34	WH-6C-3213	Run 1	0.02	0.03	
		Run 2	0.02	0.04	
		Average	0.02	0.04	3.97
Reagent NaCl (Blank)			0.009	0.01	10.7

Table 15. Compositions of Bayou Choctaw Brines in Molar Units
Units are moles per 100 g of brine

Sample		Na^+	K^+	Ca^{++}	Cl-	$SO_4^=$
SPR-74	BC-l-927	0.433	0.00051	0.00122	0.446	0.0011
SPR-65	BC-l-1219	0.433	0.00066	0.00062	0.448	0.0010
SPR-76	BC-l-1511	0.435	0.00066	0.00062	0.446	0.0010
SPR-75	BC-1-1803	0.438	0.00069	0.00045	0.451	0.0010
SPR-77	BC-4-653	0.271	0.00082	0.0070	0.296	0.0029
SPR-66	BC-4-1003	0.433	0.0022	0.0032	0.451	0.0030
SPR-78	BC-4-1353	0.430	0.0022	0.0032	0.451	0.0030
SPR-79	BC-4-1704	0.430	0.0021	0.0030	0.451	0.0031
SPR-80	BC-8A-1419	0.428	0.00023	0.00045	0.443	0.0010
SPR-82	BC-8A-1146	0.427	0.00064	0.0042	0.432	0.0043
SPR-81	BC-8A-1692	0.434	0.00026	0.00075	0.451	0.0010
SPR-67	BC-8A-1964	0.435	0.00023	0.00117	0.446	0.0018
SPR-101	BC-20A	0.268	0.00036	0.00112	0.273	0.0010
SPR-113	BC-20A-3800	0.438	0.00023	0.00037	0.423	0.00043
SPR-114	BC-20A-3850	0.438	0.00023	0.00047	0.423	0.00045
SPR-115	BC-20A-3900	0.453	0.00033	0.00097	0.448	0.00096
SPR-116	BC-20A-4000	0.457	0.00033	0.00095	0.451	0.00096
SPR-117	BC-20A-4100	0.453	0.00036	0.00095	0.451	0.00097
SPR-118	BC-20A-4200	0.453	0.00036	0.00095	0.451	0.00097

Table 14. Compositions and Densities of Bayou Choctaw Brine Samples

Sample	Collection Date	Density Measurement Temperature °C	Density g/mL (± 0.01)	pH	Na^+ (mg/g)	K^+ (mg/g)	Ca^{++} (mg/g)	Mg^{++} (mg/g)	Cl^- (mg/g)	SO (mg/g)
SPR-74 BC-l-927	5/29/80	34.4	1.19	11.2	99.6	0.20	0.49	<0.01	158.	1.1
SPR-65 BC-l-1219	5/29/80	31.1	1.20	7.5	99.5	0.26	0.25	0.014	159.	1.0
SPR-76 BC-1-1511	5/29/80	34.4	1.20	7.9	100.1	0.26	0.25	0.017	158.	1.0
SPR-75 Bc-1-1803	5/29/80	35.3	1.19	7.9	100.6	0.27	0.18	0.015	160.	1.0
SPR-77 BC-4-653	5/29/80	33.9	1.12	6.9	62.4	0.32	2.8	0.32	105.	2.8
SPR-66 BC-4-1003	5/29/80	31.1	1.20	6.5	99.5	0.85	1.3	0.063	160.	2.9
SPR-78 BC-4-1353	5/29/80	34.4	1.20	6.4	98.9	0.85	1.3	0.063	160.	2.9
SPR-79 BC-4-1704	5/29/80	34.2	1.19	7.1	98.8	0.82	1.2	0.049	160.	3.0
SPR-80 BC-8A-1419	5/29/80	35.6	1.19	7.9	98.5	0.09	0.18	0.015	157.	1.0
SPR-82 BC-8A-1146	5/29/80	35.3	1.19	7.7	98.2	0.25	1.7	0.032	153.	4.1
SPR-81 BC-8A-1692	5/29/80	33.9	1.20	7.4	99.7	0.10	0.30	0.018	160.	1.0
SPR-67 BC-8A-1964	5/29/80	35.0	1.20	8.2	100.0	0.09	0.47	<0.01	157.	1.7
SPR-101BC-20A	4/2/81	29.0	1.11		61.5	0.14	0.45		96.7	0.97
SPR-113BC-20A-3800		21.7	1.19	-	100.8	0.09	0.15	-	150.	0.41
SPR-114BC-20A-3850		21.1	1.19	-	100.8	0.09	0.19		150.	0.43
SPR-115BC-20A-3900		21.4	1.20	-	104.2	0.13	0.39		159.	0.92
SPR-116BC-20A-4000		21.4	1.20	-	105.0	0.13	0.38		160.	0.92
SPR-117BC-20A-4100		21.2	1.20	-	104.2	0.14	0.38		160.	0.93
SPR-118BC-20A-4200		21.1	1.20	-	104.2	0.14	0.38		160.	0.93

Other Results - SPR-65, 67, SPR-74-82 $CO_3^=$ and HCO_3^- $\leq$ 0.2 mg/g.
SPR-65, 66, 67 Ethane by gas chromatograph - not detected ($\leq$ 1 µg/g)

Table 16. Compositions and Densities of Sulfur Mines Brine Samples.

Sample		Collection Date	Density Measurement Temperature °C	Density g/mL (+0.01)	pH	Na+ (mg/g)	K^+ (mg/g)	Ca^{++}	Cl (mg/g)	SO_4^- (mg/g)
SPR-102	SM-6Y-3220	2/11/80	20.5	1.20		100.	0.0050	0.433	160.	1.15
SPR-103	SM-6Y-3270	2/11/80	21.0	1.20		102.	0.0083	0.390	162.	1.18
SPR-104	SM-6Y-3340	2/11/80	21.3	1.20		101.	0.017	0.423	161.	1.15
SPR-105	SM-6Y-2950	2/11/80	21.2	1.20		100.	0.0083	0.417	160.	1.12
SPR-106	SM-6Y-3090	2/11/80	21.9	1.20		101.	0.010	0.417	161.	1.13
SPR-107	SM-6Y-3030	2/11/80	21.3	1.20		100.	0.010	0.440	160.	1.13
SPR-108	SM-6Y-3140	2/11/80	21.4	1.20		95.	0.0083	0.420	160.	1.15
SPR-109	SM-2A-2450	6/11/81	21.	1.20	6.94	103.8	0.0016	0.783	159.6	1.84
SPR-110	SM-2A-2500	6/11/81	21.	1.20	7.09	104.3	0.0017	0.783	159.7	1.83
SPR-111	SM-2A-2750	6/11/81	21.	1.20	6.96	104.3	0.0016	0.799	159.0	1.85
SPR-112	SM-2A-2965	6/11/81	21.	1.20	6.99	104.9	0.0017	0.791	159.0	1.84
SPR-119	SM-7C-2950	6/15/81	34.	1.19		104.			160.7	
SPR-120	SM-7C-3030	6/15/81	38.	1.19		106.			160.0	
SPR-121	SM-7C-3090	6/15/81	43.	1.19		107.			160.9	
SPR-122	SM-7C-3140	6/15/81	50.	1.19		104.			161.0	
SPR-123	SM-7C-3220	6/15/81	29.	1.19		105.			159.2	
SPR-124	SM-7C-3270	6/15/81	38.	1.19		104.			156.9	
SPR-125	SM-7C-3340	6/15/81	42.	1.19		108.			161.1	
SPR-126	SM-7C-2860	6/22/81	32.	1.19		103.			159.3	
SPR-127	SM-7C-2945	6/22/81	23.	1.20		106.			160.1	
SPR-128	SM-7C-3030	6/22/81	24.	1.19		105.			160.6	
SPR-129	SM-7c-3130	6/22/81	25.	1.19		105.			158.8	
SPR-130	SM-4-2700	7/29/81	39.	1.19		106.			161.1	
SPR-131	SM-4-2800	7/29/81	41.	1.19		106.			161.3	
SPR-132	SM-4-2900	7/29/81	35.	1.20		104.			160.4	
SPR-133	m-4-3000	7/29/81	39.	1.20		105.			161.1	

NOTES: SPR-102-107 Na+ valuesmaybe systematically low by 2 to 4%.
SPR-108 Na^+ value may be 9% low.
SPR-119 and 130 A few salt crystals were undissolved at time of sampling.

Table 17. Compositions of Sulfur Mines Brines in Molar Units
Units are moles per 100 g of brine

Sample		Na^+	K^+	Ca^{++}	Cl^-	$SO_4^=$
SPR-102	SM-6Y-3220	0.435	1.3x10-5	0.00108	0.451	0.00120
SPR-103	SM-6Y-3270	0.444	2.1x10-5	0.00097	0.457	0.00123
SPR-104	SM-6Y-3340	0.439	4.3x10-5	0.00106	0.454	0.00120
SPR-105	SM-6Y-2950	0.435	2.1x10-5	0.00104	0.451	0.00117
SPR-106	SM-6Y-3090	0.439	2.6x10-5	0.00104	0.454	0.00118
SPR-107	SM-6Y-3030	0.435	2.6x10-5	0.00110	0.451	0.00118
SPR-108	SM-6Y-3140	0.413	2.1x10-5	0.00105	0.451	0.00120
SPR-109	SM-2A-2450	0.452	4.1x10-6	0.00195	0.450	0.00192
SPR-110	SM-2A-2500	0.454	4.3x10-6	0.00195	0.450	0.00191
SPR-111	SM-2A-2750	0.454	4.1x10-6	0.00199	0.448	0.00193
SPR-112	SM-2A-2965	0.456	4.3x10-6	0.00197	0.448	0.00192
SPR-119	SM-7C-2950	0.452	-		0.453	
SPR-120	SM-7C-3030	0.461	-		0.451	
SPR-121	SM-7C-3090	0.465	-		0.454	
SPR-122	SM-7c-3140	0.452	-		0.454	
SPR-123	SM-7C-3220	0.457	-		0.449	
SPR-124	SM-7C-3270	0.452	-		0.443	
SPR-125	SM-7C-3340	0.470	-		0.454	
SPR-126	SM-7C-2860	0.448	-		0.449	
SPR-127	SM-7C-2945	0.461	-		0.452	
SPR-128	SM-7c-3030	0.457	-		0.453	
SPR-129	SM-7C-3130	0.457	-		0.448	
SPR-130	SM-4-2700	0.461	-		0.454	
SPR-131	SM-4-2800	0.461	-		0.455	
SPR-132	SM-4-2900	0.452	-		0.452	
SPR-133	SM-4-3000	0.457	-		0.454	

Table 18. Concentrations of NO_3^- and $PO_4^{\equiv}$ in Four Sulfur Mines Brines.
Units are µg/g, uncertainties are ± a factor of 2.

Sample		NO_3^- (µg/g)	$PO_4^{\equiv}$ (µg/g)
SPR-109	SM-2A-2450	7.9	1.7
SPR-110	SM-2A-2500	3.2	9.2
SPR-111	SM-2A-2750	5.2	2.7
SPR-112	SM-2A-2965	6.5	1.3

Table 19. Compositions and Densities of West Hackberry Brine Samples

Sample		Collection Date	Density Measurement Temperature °C	Density g/mL (± 0.01)	Cl^- (mg/g)	$SO_4^=$ (mg/g)	Fe (mg/g)
SPR-38	WH-6B-3270	3/19/80	48.3	1.19	157.2	1.39	
SPR-39	WH-6B-3310	3/19/80	48.3	1.19	157.6	1.42	0.0034
SPR-40	WH-6B-3350	3/19/80	48.6	1.19	156.9	1.40	
SPR-41	WH-6B-3390	3/19/80	47.5	1.19	157.0	1.43	
SPR-42	WH-6C-3275	3/22/80	47.5	1.19	156.7	1.47	0.048
SPR-43	WH-6C-3310	3/22/80	47.8	1.19	156.4	1.47	
SPR-44	WH-6C-3345	3/22/80	48.1	1.19	154.6	1.39	0.0034
SPR-45	WH-6C-3380	3/22/80	47.8	1.19	155.0	1.36	0.0069
SPR-68	WH-6-3265	5/4/80	43.9	1.19	159.4	1.55	
SPR-69	WH-6-3325	5/4/80	47.2	1.18	158.6	1.51	
SPR-70	WH-6-3355	5/4/80	47.8	1.18	154.1	1.44	
SPR-71	WH-6-3385	5/4/80	43.9	1.18	156.4	1.50	
SPR-88	WH-6-3265	9/23/80	47.8	1.18	156.0	1.50	
SPR-89	WH-6-3385	9/22/80	48.3	1.19	160.0	1.50	
SPR-90	WH-6-3355	9/23/80	48.9	1.20	159.0	1.50	
SPR-91	WH-6-3325	9/23/80	88.9	1.20	163.0	1.7±0.3	
SPR-92	WH-6-3265	10/14/80	46.1	1.19	160.0	1.70	
SPR-93	WH-6-3325	10/14/80	46.1	1.19	161.0	1.50	
SPR-94	WH-6-3355	10/14/80	46.1	1.19	158.0	1.50	
SPR-95	WH-6-3375	10/14/80	46.1	1.19	160.0	1.50	

Table 20. Compositions of West Hackberry Brines in Molar Units
Units are moles per 100 g of brine.

Sample		Cl^-	$SO_4^=$
SPR-38	WH-6B-3270	0.443	0.00145
SPR-39	WH-6B-3310	0.445	0.00148
SPR-40	WH-6B-3350	0.443	0.00146
SPR-41	WH-6B-3390	0.443	0.00149
SPR-42	WH-6C-3275	0.442	0.00153
SPR-43	WH-6C-3310	0.441	0.00153
SPR-44	WH-6C-3345	0.436	0.00145
SPR-45	WH-6C-3380	0.437	0.00142
SPR-68	WH-6-3265	0.450	0.00161
SPR-69	WH-6-3325	0.447	0.00157
SPR-70	WH-6-3355	0.435	0.00150
SPR-71	WH-6-3385	0.441	0.00156
SPR-88	WH-6-3265	0.440	0.00156
SPR-89	WH-6-3385	0.451	0.00156
SPR-90	WH-6-3355	0.448	0.00156
SPR-91	WH-6-3325	0.460	0.0018±0.0003
SPR-92	WH-6-3265	0.451	$\overline{0.00177}$
SPR-93	WH-6-3325	0.454	0.00156
SPR-94	WH-6-3355	0.446	0.00156
SPR-95	WH-6-3375	0.451	0.00156

Table 21. Results of analyses of residue from West Hackberry brines, of a West Hackberry sidewall sample for oil, and of a Bryan Mound brine for Ag and Au; and results of a qualitative x-ray fluorescence analysis of West Hackberry core samples

Sample		Analysis	Results
SPR-38 - SPR-45	WH-6B,6C	X-ray diffraction of combined water insoluble residues filtered from these brines.	Found Barite ($BaSO_4$) - probably a residue from drilling mud
SPR-46	WH-6B-3030	Search for oil in sample by gas chromatography	Oil found in sample resembled a refined oil such as "3-in-1" or "Inland 15" - did not resemble Kern River crude or WH #6 crude.
SPR-73	BM-cavern#2	Analyze for Ag and Au	Ag $\leq$ 0.01 μg/mL; Au $\leq$ 0.02 μg/mL
SPR-96	WH-114-3693	Qualitative analysis of core by x-ray fluorescence	Major: Na, S, Cl, Ca Minor: Si, Al?, K, Fe?, Ba?
SPR-98	WH-107-2436	Qualitative analysis of core by x-ray fluorescence	Major: Na, S, Cl, Ca Minor: -
	WH	Qualitative analysi by x-ray fluorescen	Major; Na, S, Cl Ca Minor: Al?, Si, K

Table 22. Analysis of water insoluble residue from oil treated Bryan Mound salt core. See sample description of this report for details of sample identification and oil treatment. SPR-136 is crude oil.

		SPR 134	SPR 135	SPR 136
Mineralogy by x-ray diffraction		Anhydrite Halite	Anhydrite Halite	-
H content (Wt.%)	Run 1	0.072	0.18	11.30
	Run 2	0.069	0.18	11.95
	Run 3	-		11.65
	Average	0.071	0.18	11.6
C content (Wt.%)	Run 1	0.54	1.30	85.44
	Run 2	0.53	1.33	85.08
	Run 3			85.49
	Average	0.52	1.32	85.3
Wt.% oil in sample		0.63	1.55	100.0

Table 23. Results of analyses of Bryan Mound anhydrite "sand" and beach sand leachates

Sample	pH	Void Volume	Cl'
SPR-52 Beach sand leachate	7.8		2.09 mg/g of sample leached
SPR-53 Brine collected during 10 min. of draining	7.1		50,000 ± 6000. mg/L of brine
SPR-53 Anhydrite sand leachate	7.0		24.30 mg/g of sample leached
SPR-54 Anhydrite sand leachate	7.2		0.20 mg/g of sample leached
SPR-55 Anhydrite sand leachate	7.0		0.080 mg/g of sample leached
SPR-56 Anhydrite sand leach ate	7.6	26%	0.006 mg/g of sample leached

Table 24. Saturated solution of NaCl in water expressed in various units and in terms of NaCl, Na^+ and Cl' concentrations at 20°C

NaCl is Measured

35.7	g NaCl/100 g H20
26.3	g NaCl/100 g Brine
263.	g NaCl/1000 g Brine (also o/oo or parts per thousand by weight)
263000.	µg NaCl/g Brine (also ppm or parts per million by weight)
316000.	µg NaCl/mL Brine
316000.	mg NaCl/L Brine
316.	mg NaCl/mL Brine

Cl^- is Measured

21.7	g Cl^-/100 g H_2O
16.0	g Cl^-/100 g Brine
160.	g Cl^-/1000 g Brine (also o/oo or parts per thousand by weight)
160000.	µg Cl^-/g Brine (also ppm or parts per million by weight)
192000.	µg Cl^-/mL Brine
192000.	mg Cl^-/L Brine
192.	mg Cl-/mL Brine

Na^+ is Measured

14.0	g Na^+/100 g H_2O
10.3	g Na^+/100 g Brine
103.	g Na^+/1000 g Brine (also o/oo or parts per thousand by weight)
103000.	µg Na^+/g Brine
124000.	µg Na^+/mL Brine
124000.	mg Na^+/L Brine
124.	mg Na^+/mL Brine

NOTES:
1. A density of 1.200 g/cm^3 for a saturated NaCl solution in water at 20°C was used.
2. Total variation in NaCl solubility is less than 7 percent in the temperature range 0°C to 100°C.
3. In a natural brine, other salts may also be present and alter the above values slightly.
4. "Salinity" is usually defined as the mass of all salts in grams in 1000 grams of brine. The above table considers only NaCl.

Table 25. Densities of solutions of salts

Salt	Solution Density g/cm^3	Temperature °C	Reference
NaCl	1.196*	30	3
KC1	1.182*	30	3
CaC12	1.389†	40	3
$MgCl_2$	1.277†	30	3
Na_2SO_4	1.286"	30	3
$MgSO_4$	1.292†	30	3
KS04	1.0908*	30	3
Seawater	1.03	"room temp."	4
Maximum density for evaporating seawater**	1.31	"room temp."	4

*Saturated
†Not saturated
**Saturated with NaCl, CaS04, MgC12 (and perhaps also KC1)

ACKNOWLEDGMENTS

Many people formerly and currently in Divisions 1821 and 1822 of Sandia National Laboratories contributed to the analyses in this report. Among these are: F. B. Burns, N. E. Campbell, S. L. Erickson, R. M. Fischbach, J. L. Golden, M. Gonzales, E. J. Graeber, S. G. Hallett, D. M. Heinze, R. J. Kottenstette, H. S. Levine, R. M. Merrill and P. J. Rodacy. R. R. Beasley, K. L. Goin, J. F. Ney, T. S. Ortiz and others from Division 9757 assisted with sample selection.

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